Defense Energy Support Center

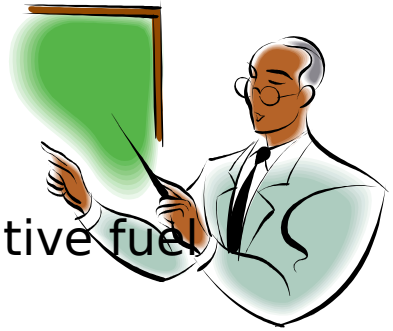
Product
Technology
&
Standardization
Division

Alternative Fuels Information Station

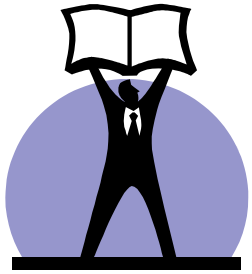
Fuel Ethanol (E85) Tutorial

Learning Objectives

You should learn….



- The definition of Fuel Ethanol
- The role of Fuel Ethanol as an EPAct 1992 alternative fuel
- How Fuel Ethanol is made
- The advantages and disadvantages of using Fuel Ethanol
- Physical and chemical Properties of Fuel Ethanol
- The handling and Storage requirements for Fuel Ethanol



Using Ethanol (E85) Fuel to Comply with EPAct

Defense Energy Support Center

Energy Policy Act 1992

E.O. 13149:
Greening the Government through Federal Fleet & Transportation Efficiency

The Federal Fleet Program

EPAct 1992

Requires that 75% of federal's covered light duty vehicle acquisitions be AFVs.

E.O. 13149

stablished a petroleum reduction goal of 20% by 2005 compared to 1999 baseline.

Acquiring AFVs and using alternative fuels are integral to achieving this goal.

INTRODUCTION OF ETHANOL

PRODUCT DEFINITIONS

Pure Ethanol (E100)

(ethyl alcohol, grain alcohol) is an alcohol made from grain and other agricultural products

Ethanol Blends(Exx)

Alcohol fuel blends designated by E and followed by a number representing the percentage of alcohol (by volume) in the blend.

Examples:

- **The fuel E10 is made of 10% denatured (unfit to drink) ethanol blended with 90% gasoline.**
- **E85, commonly called *fuel ethanol*, is made of 85% denatured ethanol blended with 15% gasoline.**
- **E100 is 100% denatured ethanol.**

Ethanol and Flexible Fuel Vehicles (FFVs)

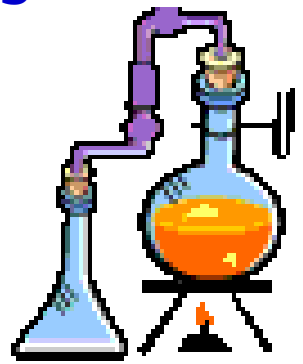
What is a FFV?

- FFVs are specially designed to run on all ethanol blends up to 8
- FFVs can use any mixture of gasoline or E85
- FFVs observe a mileage reduction on E85 vs. gasoline
- FFVs have fuel sensors which monitor ethanol/gasoline ratio

All E85

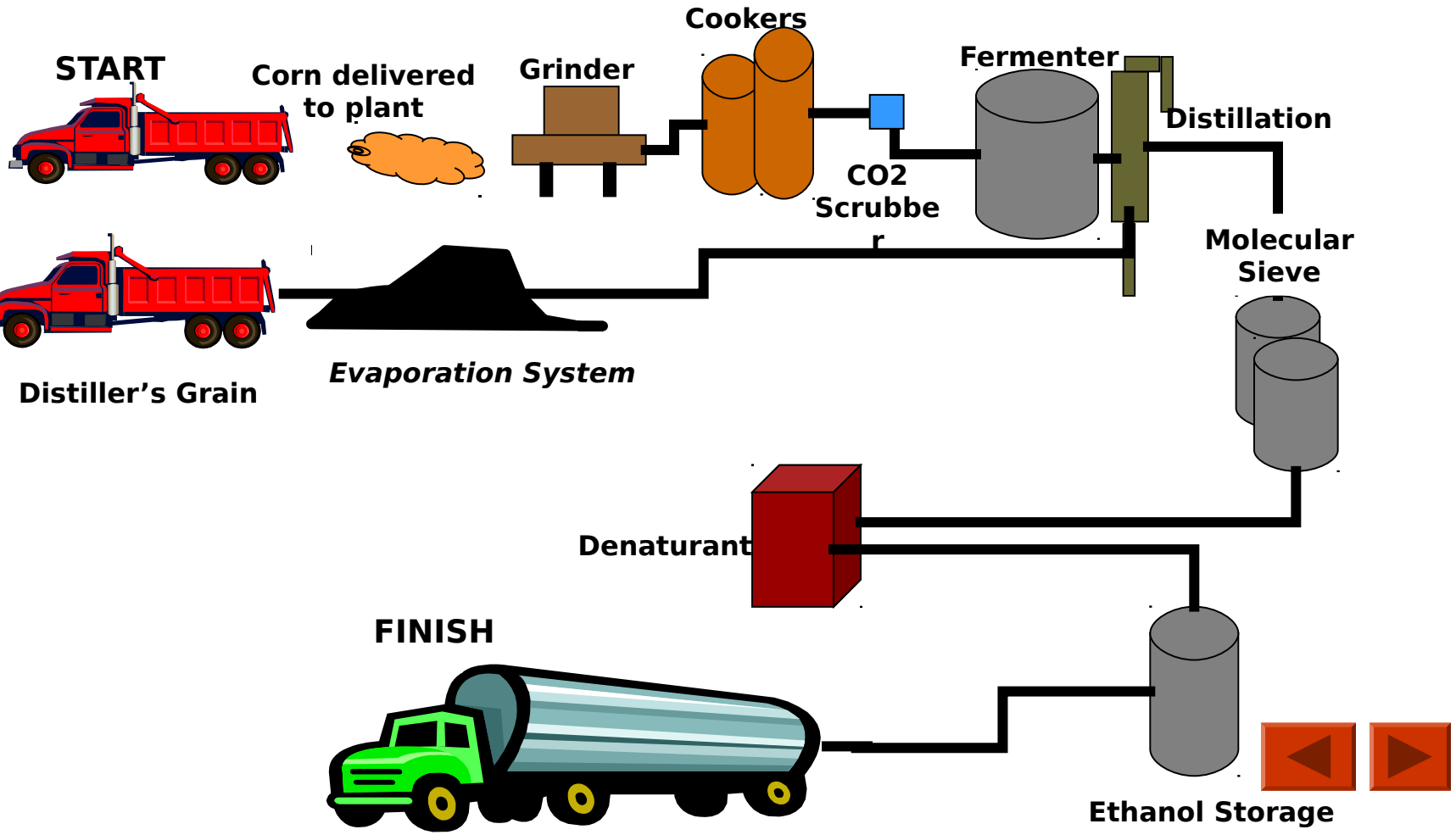
% Mixture

All Gasoline



Source: National Ethanol Vehicle Coalition

How is E85 Made?



Source: www.ethanol2000.com

Ethanol Properties

Ethanol & E85 vs. Gasoline

Property	Ethanol	Gasoline (87 Octane)	E85
Octane (R+M)/2	98-100	86-94	96
Lower Heating Value(Btu/lb)	11,500	18,000-19,000	12,500
Gallon Equivalent	1.5	1	1.4
Miles per Gallon vs. Gasoline	70%	100%	72%
Relative tank size to yield (Driving range equivalent to gasoline)	Tank is 1.5 times Larger	1	Tank is 1.4 times Larger
Reid Vapor Pressure (PSI)	2.3	8 to 16	6 to 12
Specific Gravity (@ 60/65 F)	0.794	.72-.78	0.78
Cold Weather Starting	Poor	Standard	As good as gasoline
Vehicle Power	5% Increase	Standard	3%-5% Increase
Air/Fuel Ratio (by weight)	9	14.7	10

Ethanol/E85 Properties

Ethanol Fuel Properties vs. Gasoline Fuel Properties

Property	Analysis
Vapor Density	Ethanol vapor and gasoline vapor are denser than air and settles in low areas; ethanol vapor disperses quicker
Solubility in Water	E85 will mix with water up to certain concentrations where it actually separates
Energy Constant	At equal volumes, E85 contains less energy than gasoline (approx .72)
Flame Visibility	Ethanol Fuel flames are less bright than gasoline, but still very visible in daylight.
Specific Gravity	Pure ethanol and blends are heavier than gasoline
Conductivity	Ethanol and Ethanol Blends are conductors; Gasoline is an insulator
Fuel-to-Air Ratio	E85 needs more fuel per pound of air relative to gasoline; E85 therefore cannot be used in conventional vehicles
Toxicity	Ethanol has no carcinogenic compounds; E85 is a blend which is potentially carcinogenic.
Flammability	At low temps (32 F), E85 is more flammable than gasoline. At normal temps, E85 is less flammaible (because of higher auto-ignition temp.)

Source: DOE: Handbook for Handling, Storing, and Dispensing E85

E85 Specifications

ASTM D5798-99 Standard Specification for Fuel Ethanol (Ed75Ed85) For Automotive Spark-Ignition Engines

Property	Value for Class			Test Method
ASTM volatility class	1	2	3	N/A
Ethanol, plus higher alcohols (minimum volume %)	79	74	70	ASTM D5501
Hydrocarbons (including denaturant) (volume %)	17-21	17-26	17-30	ASTM D4815
Vapor pressure at 37.8°C				
kPa	38-59	48-65	66-83	ASTM D4953, D5190, D5191
psi	5.5-8.5	7.0-9.5	9.5-12.0	
Lead (maximum, mg/L)	2.6	2.6	3.9	ASTM D5059
Phosphorus (maximum, mg/L)	0.3	0.3	0.4	ASTM D3231
Sulfur (maximum, mg/kg)	210	260	300	ASTM D3120, D1266, D2622
Methanol (maximum, volume %)		0.5	N/A	
Higher aliphatic alcohols, C3-C8 (maximum volume %)		2		N/A
Water (maximum, mass %)		1.0		ASTM E203
Acidity as acetic acid (maximum, mg/kg)		50		ASTM D1613
Inorganic chloride (maximum, mg/kg)		1		ASTM D512, D7988
Total chlorine as chlorides (maximum, mg/kg)		2		ASTM D4929
Gum, unwashed (Maximum, mg/100 mL)		20		ASTM D381
Gum, solvent-washed (maximum, mg/100 mL)		5.0		ASTM D381
Copper (maximum, mg/100 mL)		0.07		ASTM D1688
Appearance		Product shall be visibly free of suspended or precipitated contaminants (shall be clear and bright).		Appearance determined at ambient temperature or 21°C (70°F), whichever is higher.

N/A = Not applicable

Source: DOE: Handbook for Handling, Storing, and Dispensing E85

E85 Fuel Management

In many cases, existing, gasoline, diesel, or other hydrocarbon fueling systems are suitable to store and dispense E85

Use of Existing Fueling Systems

Many metal and fiberglass tanks which meet EPA codes, Dec. 98 are compatible with E85

Fiberglass tanks manufactured before 1992 *MAY NOT* be able to store E85

Preparing Existing Fueling Systems

DO NOT use plated steel tanks!!!

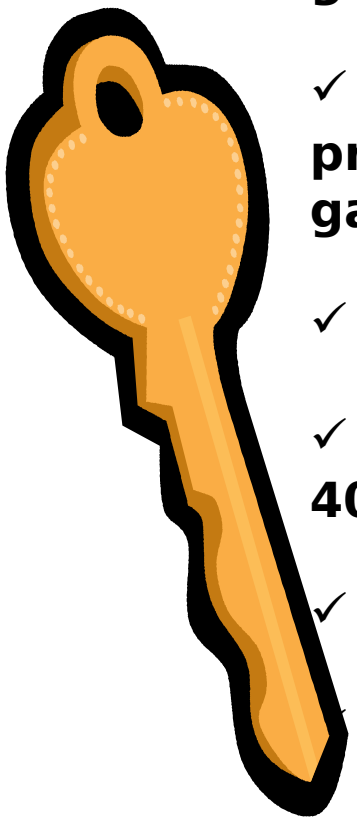
Tank cleaning is required to remove gasoline particulates.

The cleaning technique chosen will depend on the previous fuel stored and the condition of the tan

Contaminated fuel is the most common source of operational problems with E85!!!

Source: Handbook for Handling, Storing, and Dispensing E85

Key Advantages of E85



- ✓ **Flexible Fuel Vehicles are cost equivalent to gasoline vehicles**
- ✓ **Original Equipment Manufacturers (OEMs) produce and warranty FFVs similarly to gasoline vehicles**
- ✓ **Reduces smog forming pollutants by 25%**
- ✓ **Reduces greenhouse gas emissions by 35% to 40%**
- ✓ **Increased vehicular horsepower by 5%**
- ✓ **Renewable fuel made from agricultural crop**

Source: National Ethanol Vehicle Coalition, E85 Presentation, Jan. 9, 2001

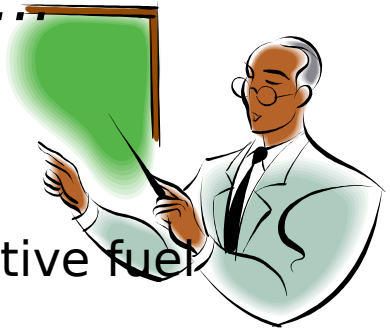
Present Limitations of E85

- X **Reduces miles/gallon vs. gasoline**
- X **Still available in limited quantities**
- X **Limited distribution capabilities**

Source: National Ethanol Vehicle Coalition, E85 Presentation, Jan. 9, 2001

Summary

You should now know and understand…



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